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# DISABILITY COSTS AND EQUIVALENCE SCALES IN THE OLDER POPULATION IN GREAT BRITAIN

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We use a standard of living (SoL) approach to estimate older people's disability costs, using data on 8000 individuals from the U.K. Family Resources Survey. We extend previous research in two ways. First, by allowing for a more flexible relationship between SoL and income, the structure of the estimated disability cost and equivalence scale is not dictated by a restrictive functional form assumption. Second, we allow for the latent nature of disability and SoL, addressing measurement error in the disability and SoL indicators in surveys. We find that disability costs are strongly related to severity of disability, and vary with income in absolute and proportionate terms. Older people above the median disability level require an extra £99 per week (2007 prices) on average to reach the SoL of an otherwise similar person at the median. Costs faced by older people in the highest decile of disability average £180.

**JEL Codes**: C81, D10, I10

**Keywords**: costs of disability, disability indexes, equivalence scale, standard of living, structural equation modeling

## 1. INTRODUCTION

Disabled people experience significant additional costs as a consequence of their disability. This is recognized in social security systems through the provision of benefits designed to compensate for disability-related consumption costs. There is no consensus on the scale of these costs (Stapleton *et al*., 2008) and thus it is hard to assess how far social security systems compensate for them in practice. In the U.K., older people with disabilities may be entitled to one of two social security benefits which are intended to help with the extra costs of disability: Attendance Allowance (AA) and Disability Living Allowance (DLA). AA can be claimed only by people aged 65 and over; DLA must be claimed before reaching age 65, but if

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awarded, can continue past age 65.[1] AA is paid at one of two rates depending on level of disability or care needs. DLA has a care component and a mobility component. The care component is payable at one of three levels corresponding to different degrees of care need; the mobility component is paid at one of two rates according to mobility needs.[2] About a quarter of people aged 65 and over receive AA or DLA (Hancock and Pudney, 2013). The benefits are not means tested although they can trigger additional entitlements to means-tested benefits through a Severe Disability Premium.[3] People with care needs may also be entitled to publicly-funded and largely means-tested social care in their own homes or in care homes. Such care is received by only 6 percent of the older population (Wittenberg *et al.*, 2011). There is continuing international debate on how best to fund the care needs of growing numbers of older people (Da Roit and Le Bihan, 2010; Gleckman, 2010; Swartz *et al.*, 2012). The role of cash disability benefits in the overall system of public support for care needs is an important part of this debate. It is therefore important to have methods to derive evidence on the extent to which the levels of cash disability benefits compensate for the extra costs that different degrees of disability bring. Moreover, when carrying out analysis of the distributional impact of tax and social security benefit reforms, it is crucially important to make some allowance for these additional living costs. If disability benefits are included in income, failure to do so would give a misleadingly favorable view of the position of disabled people in the income distribution (Hancock and Pudney, 2013).

At least five different methods have been used to estimate and adjust for the costs of disability. One is to exploit the existing benefit system and assume that the political process has resulted in an acceptable evaluation of disability costs. This implies use of an income measure for distributional analysis which excludes any receipt of disability benefit (see Hancock and Pudney, 2013; Hancock *et al.*, 2013), on the assumption that income from disability benefit is exactly offset by the extra costs of disability. However, in practice such payments follow simple rules not well tailored to each individual's specific configuration of impairments and they are not necessarily intended to meet the full costs of disability. There may also be imperfections in the eligibility judgments made by program administrators and non-take-up by potential claimants. Consequently, this approach may give a poor approximation to disability costs, with underestimation in many cases, leading to bias in distributional analysis. Clearly it cannot be used to assess the adequacy of existing disability benefit levels.

A second, judgment-based, approach attempts to estimate the disability costs by asking a panel of "experts," or disabled people themselves, to identify disability-related costs: see Martin and White (1988), Thompson *et al.* (1990), and Smith *et al.* (2004) for examples of this approach. The difficulty here is that the appropriate costs may depend not only on the nature of the impairments suffered by the individual, but also other characteristics that vary across households, and it

[1]From April 2013, DLA will start to be replaced by Person Independence Payment which will differ from DLA in certain details (Welfare Reform Act, 2012).

[2]In 2007, the year to which our data relate, the two rates of AA were £64.50 or £43.15. In 2007 the levels of DLA were such that weekly payments ranged from £17.75 to £109.50.

[3]Worth up to £48.45 in 2007 for an older disabled person receiving a means-tested benefit.

is not feasible to use expert judgment at the level of individual respondents to large-scale surveys. Disabled people themselves may also find it difficult to envisage and evaluate the counterfactual situation in which their disability is removed but all else remains constant.

A third "objective" revealed preference approach constructs an equivalence scale by using the consumption pattern (typically the household's food budget share) as an indicator of living standards in a comparison of a sample of disabled people with matched individuals who are unaffected by disability. This has been done extensively in the context of adjustment for household size and structure, but less often for disability (although see Jones and O'Donnell, 1995 for a U.K. example). The main difficulty with this revealed preference method is the need for strong assumptions to overcome inherent identification problems (Muellbauer, 1979; Pollak and Wales, 1979; Coulter *et al.*, 1992; Banks *et al.*, 1997; Deaton and Paxson, 1998).

A fourth alternative is to use a "subjective" equivalence approach, based on individuals' reported satisfaction with their well-being. Two main types of subjective information have been used: evaluations of standard of living using an arbitrary numerical scale; or judgments on the level of income believed necessary to reach a specified standard of living (see Stewart, 2009). For the subjective approach, there are concerns about the quality of subjective assessments and the failure to address problems caused by measurement error.

In this paper, we pursue a fifth and less widely-used standard of living (SoL) approach which lies somewhere between these last two approaches. The method is closely related to work on material deprivation which seeks to expand the concept of poverty beyond conventional income- or consumption-based constructs (see Berthoud *et al.*, 1993; Zaidi and Burchardt, 2005; Cullinan *et al.*, 2011). We assume that disabled people, in diverting resources to goods and services which are required because of disability, experience a lower SoL than their non-disabled counterparts. The absolute costs of disability can be identified as the additional income required by a disabled person to reach the same SoL as a non-disabled person, holding constant other characteristics, and the relative cost is the ratio of this amount to income. As Zaidi and Burchardt (2005) point out, estimates depend on the choice of a suitable standard of living indicator and the form of its relationship to income and disability status.

Our aim is to develop and improve the method further in two important respects. First, we allow for a more flexible relationship between income and SoL, so that the structure of the estimated disability cost and equivalence scale is not dictated by an unduly restrictive functional form assumption. Second, we address the problem of measurement error in disability and SoL. Both SoL and disability status are typically measured using either a binary classification or a count index based on a range of different questionnaire items.[4] Although sensitivity analyses

[4]The Katz activities of daily living (Katz *et al.*, 1963) and Barthel indices (Mahoney and Barthel, 1965) are two widely used tools for assessing ability to perform activities of daily living. These indices assign scores to self-reported degrees of difficulty in performing a number of activities, such as feeding, dressing, moving, bathing etc. Scores for each item are then aggregated. These indices have been criticized for the way reported difficulties are aggregated and for not taking account of potential measurement errors in self-reported difficulties (Feinstein *et al.*, 1986; Hartigan, 2007).

are often used to assess robustness, this is not effective if all the alternatives entail similar measurement error biases. To address this we use a latent factor model for disability and SoL, which explicitly allows for the existence of measurement errors in the observable indicators.

Using a two-latent factor structural equation model we estimate the extra cost of disability for a representative sample of people over state pension age living in private households in Great Britain, who were interviewed in the 2007/08 Family Resources Survey (FRS). Ten indicators of ability to afford particular items or activities are used to construct a latent continuous index of SoL. The latent SoL is modeled as a function of income, (latent) disability, and other characteristics, which reflect the many factors which determine an individual's achieved standard of living. In line with previous work (Hancock *et al.*, 2013), disability is assumed to be a latent concept which can be measured imperfectly by a vector of survey indicators reflecting difficulties in domains of life and is influenced by observed socio-economic and demographic characteristics of the individual.

This paper is organized as follow. Section 2 briefly describes the standard of living approach and its usage. Section 3 presents the latent-factor structural equation framework we employ. Section 4 describes the data used. Section 5 presents estimates of the structural equation model and derives the associated estimated extra costs of disability. Section 6 reports some sensitivity analysis on the initial results. The final section draws conclusions.

## 2. The Standard of Living Method

Berthoud (1991) reviews various early attempts at conceptualizing and quantifying how SoL, income, and disability are related. Berthoud *et al.* (1993) and Zaidi and Burchardt (2005) formalized this approach, which has also been used by Saunders (2007) and Cullinan *et al.* (2011) for estimating the cost of disability in Australia and Ireland, respectively. The SoL approach is illustrated in Figure 1, where we compare a positive level of disability $D$ with the baseline of non-disability, $D_0$.

The two curves plot the relation between income and SoL conditional on disability, and are assumed to increase monotonically with income. For any given value of income, the SoL of the disabled person lies below that of the non-disabled person and the vertical distance AC measures the difference in their standards of living at the level of income Y. This measure is similar to Sen's concept of "conversion handicap" (Doessel and Williams, 2011). The horizontal distance AB provides a measure of the extra income ($\Delta$) required to bring the SoL of the disabled person up to the same level as the non-disabled person.

To formalize this idea, consider the following additively separable SoL function:

$$S = f(Y) - g(D) + h(X, \varepsilon) \tag{1}$$

where $S$ is the SoL, $Y$ is a measure of financial resources, $D$ is the degree of disability status, and $X$ and $\varepsilon$ represent other observable and unobservable individual characteristics. Some individuals may be in receipt of disability benefit (B), others may not. To allow for this, we decompose income as:

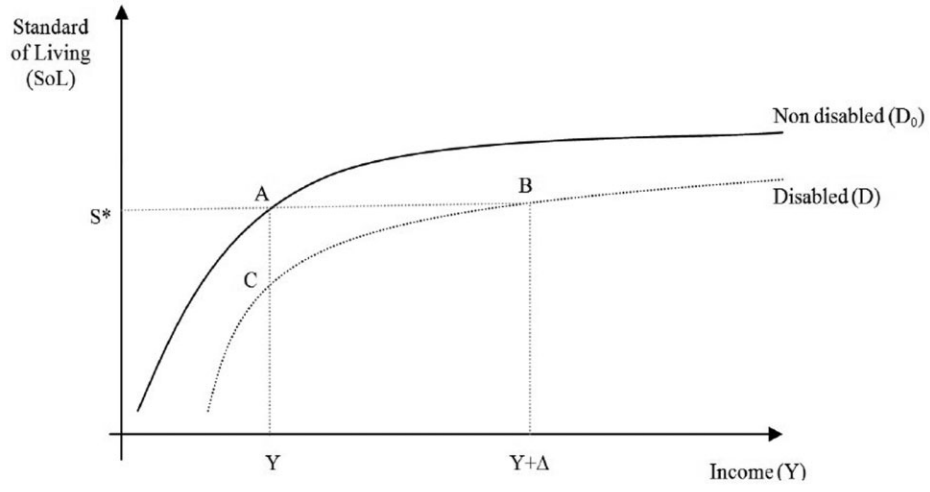


Figure 1. Standard of Living, Income, and Disability

$$Y = Y_0 + B \tag{2}$$

where $Y_0$ excludes disability benefits. Now define a reference level of disability $D_0$ and assume that the reference non-disabled person receives no disability benefit. We now pose the following question: what is the smallest amount of additional income, over and above $Y_0$, that would be needed for a person with disability level $D$ to achieve the same SoL as he or she would have with income $Y_0$ and disability reduced to the reference level $D_0$? Given the additivity of (1), this additional income need, $\Delta$, is independent of $X$ and $\varepsilon$, and solves the following optimization problem:

$$\min \Delta \quad \text{subject to:} \quad f(Y_0 + \Delta) - g(D) \geq f(Y_0) - g(D_0). \tag{3}$$

In general, the total disability-induced living cost $\Delta$ and the associated proportional equivalence scale $\sigma = (Y_0 + \Delta)/Y_0$ depend on the levels of both income $Y_0$ and disability.

For the cost $\Delta$ to depend only on severity of disability $D$ (as implied by the design of some benefit systems), the income–SoL profile must have the linear form $f(Y_0) = \gamma_1 Y_0$, in which case the cost of disability and associated equivalence scale are:

$$\Delta = \frac{g(D) - g(D_0)}{\gamma_1}; \quad \sigma = 1 + \frac{g(D) - g(D_0)}{f(Y_0)}. \tag{4}$$

For the equivalence scale $\sigma$ to depend only on disability would require $f(Y_0 + \Delta) = f(\sigma Y_0)$ to be expressible as $f(Y_0) + a(\sigma)$, for all positive $\sigma$ and some function $a(.)$. The only function satisfying this property is $f(Y_0) = \gamma_1 \ln(Y_0)$, which implies the following cost of disability and equivalence scale:[5]

[5]Strictly speaking, $f$ can be any affine transform of $\ln(Y_0)$; but an additive translation has no effect.

$$\Delta = Y_0\left[e^{\frac{g(D)-g(D_0)}{\gamma_1}} - 1\right]; \quad \sigma = e^{\frac{g(D)-g(D_0)}{\gamma_1}}. \tag{5}$$

This is the form usually adopted for equivalence scales designed to adjust for demographic differences between households in conventional income inequality analysis. Both the linear and log-linear specifications have the advantage of simplicity and incorporate the property of base independence (or invariance of the equivalence scale to income level) in additive or multiplicative form (Lewbel, 1997).

In addition to these standard forms, we also use a more flexible log-quadratic function of the kind that has been found useful in Engel curve studies (Banks *et al.*, 1997) and embodies the constant-$\sigma$ model as a special case. If $f(Y_0)$ is specified as:

$$f(Y_0) = \gamma_1 \ln(Y_0) + \gamma_2[\ln(Y_0)]^2 \tag{6}$$

then the solution to (3) gives the cost of disability and equivalence scale as:

$$\Delta = exp\left[\frac{-\gamma_1 - sgn(\gamma_2)\sqrt{\gamma_1^2 - 4\gamma_2 C}}{2\gamma_2}\right] - Y_0 \tag{7}$$

$$\sigma = Y_0^{-1} exp\left[\frac{-\gamma_1 - sgn(\gamma_2)\sqrt{\gamma_1^2 - 4\gamma_2 C}}{2\gamma_2}\right] \tag{8}$$

where $C = -[\gamma_1 \ln(Y_0) + \gamma_2[\ln(Y_0)]^2 + g(D) - g(D_0)]$. Note that this solution requires the condition $C \leq \gamma_1^2/4\gamma_2$ to be satisfied.

This emphasizes the importance of the specification used to relate SoL to income and the need to allow for the possibility of departures from the simple assumptions of linear or log-linear forms.

## 3. A Statistical Model

We use the following two-latent factor simultaneous equation model:

$$S_{iq} = \mathbf{1}(\lambda_q \varphi_i + \zeta_{iq}) \tag{9}$$

$$D_{ik} = \mathbf{1}(\mu_k \eta_i + \xi_{ik}) \tag{10}$$

$$\varphi_i = f(Y_i; \boldsymbol{\gamma}) + \alpha_1 \eta_i + \boldsymbol{\alpha}_2 \boldsymbol{x}_i + \varepsilon_{1i} \tag{11}$$

$$\eta_i = \boldsymbol{\beta} \boldsymbol{z}_i + \varepsilon_{2i} \tag{12}$$

where $i$ denotes sampled individuals ($i = 1 \ldots N$), $f(.)$ represents the linear, log-linear, or log-quadratic function and $\boldsymbol{\gamma}$ contains the corresponding coefficients.

The latent measure of SoL is $\varphi_i$ which underlies the observed SoL indicators $S_{i1} \ldots S_{iQ}$, and the latent disability index $\eta_i$ generates observed disability indicators $D_{i1} \ldots D_{iK}$. The parameters $\lambda_q$ and $\mu_k$ are factor loadings associated with the $S_{iq}$ and $D_{ik}$ indicators, respectively. $\zeta_{iq}$ and $\xi_{ik}$ are the measurement errors associated with the SoL and disability indicators. The indicator function $\mathbf{1}(.)$ maps the latent indexes on the right-hand side of the measurement equations (9) and (10) into the observed binary indicators of SoL and disability.

Observable covariates representing personal characteristics and household circumstances appear in vectors $\boldsymbol{x}_i$ and $z_i$. They contain socio-economic and demographic influences on living standards and disability, respectively. In this model socio-economic factors have both a direct and an indirect effect on SoL. Income, for example, has the direct effect of increasing resources available for consumption; this is captured by the function $f(Y_i; \boldsymbol{\gamma})$. Income also has an indirect influence on disability, through the term $\boldsymbol{\beta z}_i$, which then increases disability-related costs through the term $\alpha_1 \eta_i$. The use of a latent disability model allows us to separate these direct and indirect effects. Note that the income concepts relevant to the direct and indirect paths are different. The direct effect involves current resources available for consumption, which includes receipt of disability benefit. In contrast, modeling of the indirect effect requires a long-term concept of economic resources reflecting the cumulative effect of past living standards on the current health state. Since disability precedes the receipt of disability benefit, it follows that the latter should be excluded from the income variable used to capture the indirect causal path.

We use the standard normalizations $\text{corr}(\varepsilon_1, \varepsilon_2) = 0$ and $\text{var}(\varepsilon_1) = \text{var}(\varepsilon_2) = 1$ for the structural errors and assume the measurement errors $\zeta_{iq}$ and $\xi_{ik}$ to be independent. Because units of measurement for $\varphi$ and $\eta$ are arbitrary, we show coefficient estimates in standardized form. The variance of the latent SoL index in (11) is $\left(1-R_\varphi^2\right)$, where $R_\varphi^2$ is the squared multiple correlation of $\varphi$, so the standardized form of $\varphi$ implies multiplying each coefficient by a factor $\left(1-R_\varphi^2\right)^{-1/2}$, so that each coefficient is interpretable as the change in $\varphi$ in standard deviation units, produced by a 1-unit increase in the value of the covariate. Disability $\eta$ is also a latent construct, with variance $var(\boldsymbol{\beta z}_i)+1=\left(1-R_\eta^2\right)$, where $R_\eta^2$ is the squared multiple correlation of the disability equation. Therefore the standardized coefficient of $\varphi$ on $\eta$ is $\alpha_1^{STD} = \alpha_1\sqrt{\left[\left(1-R_\eta^2\right)/\left(1-R_\varphi^2\right)\right]}$, which can be interpreted as the change in $\varphi$ (in standard deviation units) generated by a 1-standard deviation increase in $\eta$.

## 4. Data

The data are from the 2007–08 Family Resources Survey (FRS): a large U.K. household survey collecting detailed income and assets information from respondents and asking questions covering difficulties due to ill-health or disability (Department for Work and Pensions *et al.*, 2009). The survey also includes a series of questions aimed at measuring material deprivation (Department for Work and Pensions, 2009b). For this paper we restrict the analysis to households in Great Britain where all members are over state pension age (65 for men; 60 for women) and the household contains only a single person or a couple. The age restriction is imposed in order to limit endogeneity bias which may arise for younger adults for whom disability may cause a reduced income by limiting labor market participation.[6] In estimating equations (11) and (12) we measure income at the household level, assuming that all members of the households benefit to the same extent from total household income. This is less likely to be true for households containing members other than a single or couple pensioner. After dropping a few cases where relevant information is missing, the resulting sample contains 8,183 individuals (5,812 households). About 58 percent of the sample are partnered and the remainder live alone. We retain proxy cases (4.8 percent) where the required data were provided by a proxy respondent (often a carer). Dropping proxy cases would bias the sample toward the less severely disabled.

Deprivation indicators are derived from a set of questions about items or activities, seen as potential "necessities"; households who did not have the items or do the activities were asked whether this was because they did not want them or because they could not afford them. They were also given the option of saying that an item or activity did not apply to them.[7] From these household-level indicators, we created individual-level indicators in which each household member is assigned the values of the deprivation indicators of their household. Each indicator is set to 1 if the respondent answered "We/I would like to have this but cannot afford this at the moment" and 0 otherwise. Thus we allow for differences in preferences to explain non-consumption rather than assuming that non-consumption always implies deprivation. However, it has been suggested (McKay, 2004, 2008; Berthoud *et al.*, 2009) that certain segments of the population with lowered expectations, such as disabled older people, may be less likely than others to admit to being unable to afford particular activities or goods. We have carried out two sensitivity analyses by: (i) using a restricted subset of the indicators; and (ii) using a less stringent interpretation of the responses. Results are given in Section 6.

In estimating equations (9)–(12), we invert these deprivation indicators to construct the SoL indicators, $S_{iq}$, taking the value 0 if the respondent cannot afford the activity/good and 1 otherwise. Sample statistics corresponding to the two alternative definitions of deprivation are shown in Appendix Table A1. Overall, 35 percent of the sample report an inability to afford at least one item, a proportion which rises to 80 percent under the less stringent interpretation.

FRS respondents are asked whether they have a health problem or disability and, if they answer "yes" they are asked if they have significant difficulties in each of nine areas of life. The prevalence rates for these disability indicators are reported in Appendix Table A1. Overall, 53 percent of the sample reported having no disability and 20 percent reported three or more difficulties. The most common difficulties are those concerning physical impairment (difficulties in mobility; with lifting, carrying, or moving objects).

The explanatory covariates used in the SoL and disability equations are summarized in Appendix Table A2. The income indicator $Y$ used in the

[6]For a discussion on this point we refer, amongst others, to Goldman (2001) and Adams *et al.* (2003).

[7]Taking the ability to afford to replace worn out furniture as an example, respondents who rent furnished properties may not be responsible for replacing furniture and therefore select "does not apply." In fact only 2.5 percent of the sample replied "does not apply" to at least one of the deprivation indicators.

SoL equation represents the resources of the household currently available for meeting the consumption needs of the household members. We use a household-level income measure, net of direct taxes and housing costs, similar to the "After Housing Cost" measure used in the official *Households Below Average Income* analysis (Department for Work and Pensions, 2009a) and also by Zaidi and Burchardt (2005). This measure represents the disposable income available for spending on the items and activities used as indicators of SoL. We argue that the treatment of housing as a fixed cost is reasonable in our target population, since adjustment of housing as a response to disability often takes the form of transition into the care home sector or moving into a multi-generation household. Nevertheless, we report a sensitivity test in Section 6.

Our income measure includes income from investments (interest, rent, dividends, private pensions, annuities). It includes disability benefits since, as argued earlier, they are available, like any other income component, to be used to maintain SoL (see also Zaidi and Burchardt, 2005; Stapleton *et al.*, 2008; Cullinan *et al.*, 2011). Disability benefits comprise the non-means-tested Attendance Allowance and Disability Living Allowance, an estimate of income attributable to the Severe Disability Premium component of means-tested pensioner benefits and other minor disability-related benefits that are received by a small number of older people in our sample.

The income measure used as a covariate in the disability equation also includes income from investments, since interest, rent, dividends, private pensions, and annuities are returns on assets accumulated over the lifecycle and are, consequently, good indicators of past access to resources with a cumulative positive influence on health. For the same reason, we also include a measure of financial wealth[8] in the disability equation and a dummy variable to indicate home ownership. Note that the income measure used as a covariate in the disability equation excludes current receipt of disability benefits, since those are a consequence, rather than a determinant, of current disability. Rather than use an arbitrary equivalence scale to adjust income for household composition, we include a dummy variable to indicate whether the household contains a single person or a couple in the disability and SoL equations. In line with previous work (Zaidi and Burchardt, 2005; Stewart, 2009), we also use a set of personal characteristics including age, gender, level of education, home ownership, and marital status, together with regional dummies to reflect geographical differences in cost of living and in health.

## 5. Parameter Estimates and Analysis

### 5.1. *Estimates of the Structural Equation Model*

Estimation results for the model comprising equations (9)–(12) are presented in Appendix Tables A3–A5.[9] The log-quadratic form of the SoL equation fits the

[8]Deposit and saving account balances, stocks, bonds, certificate deposits, and other savings held by the household. The information recording the amount of liquid wealth in FRS was severely affected by non-response, which we deal with by imputation based on grossing up investment income. Financial wealth is not used as a covariate in the SoL equation.

[9]Estimates were computed using the robust maximum likelihood estimator of *Mplus 6.11* (Muthén and Muthén, 2010).

data best. The estimated measurement equations (9) and (10) using this form of the SoL equation, are summarized in Appendix Table A3. They show respectively the factor loadings $\lambda_q$ which capture the effect of the latent standard of living index $\varphi$ on the indicators $S_q$, and the factor loadings $\mu_k$ associated with the disability score $\eta$. We also report the squared correlation of each indicator with the underlying latent construct. The factor loadings are all positive and highly significant. Being unable to afford to replace/renew durable goods or to keep the home in a decent state of decoration are the most sensitive indicators of the latent SoL construct $\varphi$; the inability to afford house insurance, hobbies, or leisure activities are the least sensitive. The highest correlation with the latent disability construct is found for indicators of difficulties with mobility, lifting, and dexterity, while lower correlations are found for indicators of cognitive disability.

Results reported in Appendix Table A4 show that the conditional mean of $\eta$ increases almost linearly with age, although we allowed for non-linearity using a spline function of age, with a single node at the median age 73 observed in the sample. The structural estimates provide no evidence of a significant relation with gender. Indicators measuring economic well-being are jointly significant at the 1 percent level: more educated individuals experienced a low level of disability as well as those with high current pre-disability benefit income. A negative relation between wealth and disability emerges, in terms of both housing wealth (captured by owner-occupation) and financial wealth.

Income and receipt of disability benefits by decile of latent disability are displayed in Table 1. Average weekly post-disability benefit household income (Y) is reported per-capita and without adjustment for household composition. The

TABLE 1

MEAN INCOME AND RECEIPT OF DISABILITY BENEFITS BY DECILES OF LATENT DISABILITY

| | Mean Y[a] £s pw | | | | |
|---|---|---|---|---|---|
| Decile of $\hat{\eta}$ | Per Capita | Unadjusted for Household Composition | % of Individuals Receiving Disability Benefits | % of Individual Disability Benefit Recipients in Each Disability Decile | Average Amount Of Disability Benefit[b] Received £s pw |
| 1 | 263.90 | 442.90 | 1.8 | 1.2 | 1.20 |
| 2 | 206.00 | 353.10 | 3.2 | 2.0 | 1.90 |
| 3 | 187.40 | 309.10 | 3.6 | 2.3 | 2.30 |
| 4 | 162.80 | 257.70 | 5.0 | 3.2 | 2.70 |
| 5 | 141.30 | 203.80 | 6.9 | 4.4 | 4.00 |
| 6 | 148.70 | 221.50 | 10.3 | 6.6 | 6.30 |
| 7 | 172.20 | 264.10 | 15.5 | 10.0 | 10.00 |
| 8 | 175.50 | 263.80 | 24.1 | 15.4 | 15.70 |
| 9 | 174.10 | 255.50 | 35.6 | 22.8 | 23.50 |
| 10 | 181.70 | 264.10 | 50.1 | 32.1 | 37.80 |
| *Mean for deciles 6 to 10* | *170.40* | *253.80* | *27.1* | *86.9* | *18.60* |

*Notes*: Statistics computed over a sample of 8,183 FRS 2007-8 respondents. All monetary values are rounded to the nearest 10p and expressed in 2007 prices.

[a]Household income including disability benefit.

[b]Measured at the individual level.

association between disability and socio-economic status is widely recognized (see, for instance, Goldman, 2001; Cutler *et al.*, 2011 for a review) although the extent to which this association reflects causality is still in debate (Conti *et al.*, 2010). Similarly we find that there is a strong association between disability and per-capita income which declines monotonically until the fifth decile of $\eta$ and is almost flat afterwards. Thus poor health and low income are strongly associated even if the measure of income used, as here, includes the disability benefit that individuals receive. The last three columns of Table 1 show the percentage of individuals in the sample in receipt of any disability benefit by decile of latent disability, the proportions of those recipients who are in each disability decile, and the average amount of disability benefits received by individuals in each disability decile. The proportion of individuals in the sample who receive these benefits ranges from under 2 percent in the lowest disability decile to 50 percent in the top decile. Overall, amongst those in the upper half of the disability distribution the percentage is 27 percent. Although current disability benefits appear well targeted on disabled people, a significant proportion of those who face severe disability do not receive disability benefits. Non take-up of disability benefits among disabled people has been noted elsewhere (Currie and Madrian, 1999; Pudney, 2010) and the receipt of disability benefit may often be delayed by several years after disability onset (Zantomio, 2013).

Estimates for the regression coefficients of the SoL equation are reported in Appendix Table A5, using three different functional forms of $f(Y)$: the linear-in-income model (model 1); the linear-in-log income model (model 2); and the quadratic-in-log income model (model 3). Age, level of education, home ownership, marital status, and region of residence are found to be highly significant at the 1 percent level and their signs, for the most part, are as expected. A gender dummy is not significant. Here, we focus on the structural parameters of interest in deriving the equivalence scale (Table 2). The structural estimates of the $\alpha_1$ and $\boldsymbol{\gamma}$ provide

TABLE 2

The Standard of Living Equation: Parameter Estimates (in Standardized Form) for Latent Disability and Income

| | Model (1) Linear in Y | | Model (2) Linear in ln(Y) | | Model (3) Quadratic in ln(Y) | |
|---|---|---|---|---|---|---|
| Parameter(s): | Coeff. | S.E. | Coeff. | S.E. | Coeff. | S.E. |
| $\alpha_1^{STD}$ | –0.233*** | 0.016 | –0.254*** | 0.016 | –0.236*** | 0.016 |
| $\gamma_1^{STD}$ | 0.003*** | 0.001 | 0.631*** | 0.026 | –2.610*** | 0.201 |
| $\gamma_2^{STD}$ | | | | | 0.307*** | 0.019 |
| Free parameters | 74 | | 74 | | 75 | |
| Log-likelihood | –38,718.413 | | –38,759.401 | | –38,694.623 | |
| Correction for non-normality factor | 1.004 | | 0.992 | | 0.994 | |
| AIC | 77,584.826 | | 77,666.803 | | 77,539.247 | |
| BIC | 78,103.552 | | 78,185.529 | | 78,064.983 | |

*Notes*: Significance: * = 10%; ** = 5%, *** = 1%. Models also include regional dummy variables and controls for socio-economic characteristics which are reported in Appendix Table A5. The $R^2$ of models (1), (2), and (3) are 0.384, 0.334, and 0.382, respectively.

strong evidence that latent disability and current income affect the SoL. Increased disability is associated with lower values of the SoL index, while income is positively associated with the SoL, no matter which functional form is used. Holding other variables constant, a 1-standard deviation increase in disability $\eta$ produces a reduction of 0.233 standard deviations in $\varphi$ using model 1, 0.254 using model 2, and 0.236 using model 3. The estimated income coefficients imply that a £10 increase in weekly income increases SoL by 0.03 standard deviations in model 1 and in model 2; a 10 percent increase in net income produces an increase of about 0.0631 standard deviations in the SoL. In model 3, the coefficient associated with the added square of log household income is significant at the 1 percent level, implying a significant non-linear relationship of income and the SoL index $\varphi$. Thus, controlling for disability level, disability costs appear to vary with income in both absolute terms and as a proportion of income.

At the bottom of Table 2 we report the number of free estimated regression parameters, the maximized log-likelihood and its correction for non-normality factor, the Akaike information criterion (AIC), and the Bayesian Information criterion (BIC) for the model comprising equations (9)–(12). According to these measures the quadratic-in-log form (model 3) fits the data best but, as the plots in Appendix Figure A1 show, its implications are remarkably close to those of the linear specification.

We might also want to include covariates in the SoL equation which capture the value of any informal (i.e., unpaid for) and subsidized formal care received by the person, as such care may affect the living standard a disabled person can achieve from a given level of income. Informal care received by another member of the household can be ignored as it represents a within-household transfer rather than an addition to household resources. The FRS contains limited information on receipt of informal care from non-household members and formal care although whether and how much that care was subsidized by the state is not directly recorded. We experimented with adding covariates for hours of informal care received from non-household members and hours of care from a Local Authority or nurse, in the SoL equation (income entered in log-quadratic form). None of the estimated coefficients was statistically significant at the 5 percent level and the estimated coefficients for latent disability and income were only very marginally changed by the inclusion of these additional covariates. In subsequent analysis we therefore use the models without covariates measuring receipt of care.

### 5.2. *Disability Costs and Equivalence Scales*

Using the parameter estimates in Table 2, we can derive the relative/absolute costs of disability for any reference level of disability $D_0$ as the minimal compensating amount (3). First, we calculate the model-based posterior prediction $\hat{\eta}$ as the estimate of the expectation of $\eta$ conditional on all observed information for the individual. Then we calculate the estimate of disability cost as (4), (5), or (7) evaluated at the point $\hat{\eta}$ and thus the means of these estimated costs by decile of $\hat{\eta}$.[10]

[10]Note that this is a conservative estimate, for the log-linear and (to a lesser extent) the log-quadratic model. Because of the convexity of the *exp*(.) function in (5) and (7), the true average cost will be understated: to a degree that depends on the posterior variance of $\eta$.

TABLE 3
SELF-REPORTED DIFFICULTIES BY DECILE OF $\hat{\eta}$

| Decile of $\hat{\eta}$ | % of Those Who Reported: Any Difficulties | % of Those Who Reported: Difficulties with Mobility, Lifting, Carrying or Moving Objects | Number of Difficulties Reported |
|---|---|---|---|
| 1 | 0.0% | 0.0% | 0.00 |
| 2 | 0.0% | 0.0% | 0.00 |
| 3 | 0.0% | 0.0% | 0.00 |
| 4 | 0.2% | 0.0% | 0.00 |
| 5 | 5.5% | 0.0% | 0.06 |
| 6 | 63.2% | 2.3% | 0.67 |
| 7 | 100.0% | 91.8% | 1.22 |
| 8 | 100.0% | 98.4% | 2.22 |
| 9 | 100.0% | 100.0% | 3.03 |
| 10 | 100.0% | 100.0% | 4.97 |
| *Mean* | 46.9% | 39.2% | 1.22 |

*Notes*: Statistics computed over a sample of 8,183 FRS 2007–08 respondents.

Since we use a continuous measure of disability, the definition of $D_0$ is less straightforward than when using a dichotomous indicator. We can think of $D_0$ as a reference level of disability above which some financial compensation is judged appropriate, but how should this reference level be chosen? Table 3 reports the prevalence of reported difficulties by decile of $\hat{\eta}$. As noted in Section 4, about 53 percent of the sample reported having no disability. All individuals who fall in the highest four deciles of $\hat{\eta}$ reported at least one disability, most having a difficulty with mobility, and lifting, carrying, or moving objects. The mean number of reported disabilities increases non-linearly with position in the latent disability distribution. It is clear from Table 3 that there is a definite discontinuity at the median and, as a consequence, we adopt the median level of $\hat{\eta}$ ($D_0 = 0.972$) as our reference level. Appendix Figure A2 shows the empirical kernel distribution of the predicted disability index $\hat{\eta}$ from the log-quadratic model.

Estimated costs of disability are presented in Table 4. There are 260 cases (out of 8183 in the estimation sample) where the condition $C \leq \gamma_1^2/4\gamma_2$ in equation (8) is violated. All have a combination of low income (mean £88 compared to £290 for the full sample) and low estimated latent disability (mean 0.65 compared to 1.40). In the calculations reported below, we set their disability costs to zero (dropping cases with very low income and disability leads to virtually identical estimates).

Average estimated disability costs ($\Delta$) and the equivalence scale ($\sigma$) computed among people in the upper 50 percent of the disability distribution are displayed in Table 4 by deciles of $\hat{\eta}$ (panel a) and by deciles of household income (panel b) for each of the three model variants. From panel (a), we see that on average, a person in the upper 50 percent of the disability distribution requires an additional £90 to reach the same standard of living as a comparable person at the median level of disability, according to the linear model. Average disability costs are about £17 per week in the sixth decile of the disability distribution, rising to £164 in the top decile. For the log-linear specification the estimated disability costs are higher (about £154 per week for those in the upper 50 percent of disability) and they increase

TABLE 4

Estimated Costs of Disability and Average Equivalence Scale among Disabled People,[a] by Deciles of Latent Disability and by Deciles of Per Capita Income[b]

**Panel (a)**

| Decile of Latent Disability, $\hat{\eta}$ | Model (1) Linear in Y | | Model (2) Linear in ln(Y) | | Model (3) Quadratic in ln(Y) | |
|---|---|---|---|---|---|---|
| | Δ £s pw | σ | Δ £s pw | σ | Δ £s pw | σ |
| 6 | 17.40 | 1.11 | 23.10 | 1.10 | 22.10 | 1.21 |
| 7 | 62.00 | 1.35 | 95.10 | 1.38 | 67.80 | 1.40 |
| 8 | 91.00 | 1.50 | 149.60 | 1.60 | 98.00 | 1.54 |
| 9 | 116.30 | 1.72 | 193.10 | 1.83 | 126.10 | 1.78 |
| 10 | 163.70 | 2.06 | 307.50 | 2.36 | 179.90 | 2.17 |
| *Mean among disabled people* | *90.00* | *1.55* | *153.60* | *1.65* | *98.70* | *1.62* |

**Panel (b)**

| Decile of Per Capita Pre-Disability Benefit Income *(% of disabled people in each decile)* | Mean Y[c] £s pw | | Model (1) Linear in Y | | Model (2) Linear in ln(Y) | | Model (3) Quadratic in ln(Y) | |
|---|---|---|---|---|---|---|---|---|
| | Per-Capita | Unadjusted for Household Composition | Δ £s pw | σ | Δ £s pw | σ | Δ £s pw | σ |
| 1 *(60.1%)* | 95.10 | 141.50 | 95.60 | 2.16 | 81.50 | 1.72 | 115.60 | 2.65 |
| 2 *(59.6%)* | 109.40 | 180.20 | 88.10 | 1.63 | 106.10 | 1.64 | 89.70 | 1.65 |
| 3 *(56.7%)* | 127.60 | 204.50 | 89.80 | 1.56 | 120.70 | 1.65 | 90.90 | 1.57 |
| 4 *(63.8%)* | 136.20 | 186.60 | 87.30 | 1.58 | 111.30 | 1.63 | 87.90 | 1.57 |
| 5 *(55.0%)* | 149.30 | 211.40 | 89.20 | 1.51 | 133.20 | 1.65 | 91.00 | 1.51 |
| 6 *(52.1%)* | 167.90 | 249.50 | 92.70 | 1.47 | 155.00 | 1.68 | 96.20 | 1.47 |
| 7 *(46.2%)* | 192.90 | 287.40 | 89.90 | 1.39 | 167.40 | 1.65 | 95.40 | 1.41 |
| 8 *(42.7%)* | 226.40 | 344.70 | 88.80 | 1.31 | 205.80 | 1.63 | 100.80 | 1.34 |
| 9 *(33.2%)* | 270.00 | 403.50 | 90.10 | 1.27 | 246.90 | 1.64 | 108.60 | 1.31 |
| 10 *(30.4%)* | 412.10 | 594.90 | 88.10 | 1.17 | 377.80 | 1.63 | 130.20 | 1.23 |
| *Mean among disabled people* | *170.40* | *253.80* | *90.00* | *1.55* | *153.60* | *1.65* | *98.70* | *1.62* |

*Notes*:
[a]Disabled people defined as those in the upper 50% (deciles 6–10) of the distribution of disability, $\hat{\eta}$.
[b]Income deciles computed over the pre-disability benefits income distribution of the whole population which includes non-disabled people.
[c]Y is household income including disability benefit.

Estimates of Δ are unadjusted for household composition. All monetary values are rounded to the nearest 10p and expressed in 2007 prices. The reference disability level for computing Δ and σ is the median.

more sharply with disability. The log-quadratic model generates estimates which are much closer to those of the linear model, but with slightly higher values in the upper tail of the disability distribution. The estimated average cost of disability among the upper 50 percent of disabled people is about £99 per week; in the top decile of disability it is £180. Panel (b) of Table 4 reports equivalence scales and disability costs among disabled people by deciles of per capita pre-disability benefit income. It demonstrates that the flexible log-quadratic model allows for a more complex relationship between income and estimated disability costs/equivalence scales than the other two models. Under the log-quadratic model the estimated costs of disability are greatest for the lowest and highest income deciles. The estimated equivalence scale is largest for the lowest income decile.

It is clear that the equivalence scale, $\sigma$ increases with disability.[11] If we define a disabled person as someone with a disability in the top half of the disability distribution, an older disabled person requires, on average, an increase of about 55 percent of net weekly pre-disability household income ($Y_0$) to reach the same standard of living as a comparable non-disabled person, according to the linear model. Average disability costs are about 11 percent of $Y_0$ in the sixth decile of the disability distribution, rising to 106 percent in the top decile. For the log-linear specification, estimated disability costs are about 65 percent higher on average in the disabled population and increase more sharply with disability. The log-quadratic model generates estimates which are much closer to those of the log-linear model, but with slightly lower values in the upper tail of the disability distribution. The average extra cost of disability is about 62 percent of the net weekly pre-disability household income.

## 6. Sensitivity Analysis

In this section we assess the sensitivity of our results to: (i) the assumption that the costs of disability and the equivalence scale are independent of household composition; (ii) the income definition; and (iii) the construction of the SoL measure.

### Demographic Invariance

The three models of the previous section imply invariance of the equivalence scale to household size and structure. This has the advantage that a benefit system with the same property does not create incentives for potential claimants to change their household type to increase their level of entitlement (Pendakur, 1999). We test whether estimates of the best-fitting quadratic model are sensitive to the assumption of demographic invariance by using a two-group analysis where we allow the parameters of the SoL equations (9) and (11) to differ for respondents from single-person and two-person households. In contrasting this with the

[11]By construction, $\sigma$ obtained using models 1 and 2 is lower than 1 for those individuals who fall below the median level of disability [$g(D) < g(D_0)$] and increases afterwards. However, nothing prevents the equivalence scale derived from model 3 for some people with disability level below $D_0$ from being greater than 1. That is because the equivalence scale derived from specification 3, while increasing in disability, is decreasing in income. In practice this occurs for only 1.07 percent of the sample.

unrestricted model, the Akaike information criterion suggests that the unrestricted model provides a slightly better balance of model fit and parsimony. Panel (1) in Table 5 shows the equivalence scale and the extra cost of disability computed for single people and couples, by disability index $\eta$. It should be noticed however, that about 58 percent of single people, compared with 44 percent of couples, belong to the top four deciles of $\hat{\eta}$. Thus single people (mainly widows) on average experience higher disability levels than people in couples (see also Zaidi and Burchardt, 2005). On the other hand, household income (not adjusted for household composition) of people in couples is generally higher than for single people. Therefore the reduction in the living standard caused by a given disability level is higher (lower) in relative (absolute) terms for single people than for couples.

### Housing Wealth and Housing Costs

A further sensitivity analysis makes some allowance for housing wealth. We re-estimate equations (9)–(12) adding to the income variables in equations (11) and (12) an annual return from the (estimated) house wealth of 2 and 4 percent, respectively.[12] This increases the household income measure only for the 76 percent of people who are owner occupiers. Estimates of equivalence scales and the extra costs of disability using a 2 and 4 percent return on housing wealth are remarkably close to the base case and are reported in panel (2) of Table 5. We also test the extent to which our estimates are sensitive to the treatment of housing costs in the income measure. On average, housing costs (which are the sum of gross rents, council tax payments, costs of insurance on structure of property, and mortgage interest payments net of housing benefit and council tax benefits) are of about £8 lower for disabled people compared with the non-disabled counterpart. Using a "Before Housing Costs" income measure (see discussion in Section 4) yields an estimate of the average extra cost of disability among disabled people of £93 (about £6 lower than when income is measured after housing costs).

### SoL Indicators

We used two sensitivity tests focused on disability measurement. First, dropping the indicators for "hobby or leisure activity," "holidays away from home," and "friends and family round" produced very little change in the estimates.[13] Second, we used a less stringent interpretation, setting each indicator to 0 even in cases where respondents replied "We/I do not want/need this." This produced a slightly lower coefficient (–0.272) for disability, a higher $\gamma_1^{STD}$ (–1.793),

[12]Estimates of housing wealth are derived by estimating an interval regression using recorded Council Tax band information and a set of controlling characteristics available in the FRS. Council Tax is a local property tax for which all domestic properties have been valued and the value placed in a band. This regression gives us a vector of estimated coefficients which we use to derive homeowners' expected housing wealth conditional on being in the respondent council tax band, evaluated at the time when their properties were last valued (1991 for England and Scotland and 2005 in Wales). Finally, observed regional changes in house prices between then and 2007 are applied to yield estimated housing wealth in 2007 prices. Return on housings wealth is then computed at a weekly basis (dividing the assumed annual return by 52).

[13]We estimated $\alpha_1^{\mathrm{STD}}$, $\gamma_1^{\mathrm{STD}}$, and $\gamma_2^{\mathrm{STD}}$ as –0.236, –2.660, and 0.311, respectively, compared with –0.236, –2.610, and 0.307 for the baseline model.

TABLE 5

Sensitivity Analysis: Mean Costs of Disability and Equivalence Scale by Deciles of $\eta$

| | (1) | | | | (2) Returns from Housing Wealth | | | | (3) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Couples (N = 4752) | | Singles (N = 3438) | | 2% | | 4% | | SoL Indicator = 0 if Does Not Want/Have or Cannot Afford to, 1 Otherwise | |
| Decile of $\hat{\eta}$ | $\Delta$ £s pw | $\sigma$ | $\Delta$ £s pw | $\sigma$ | $\Delta$ £s pw | $\sigma$ | $\Delta$ £s pw | $\sigma$ | $\Delta$ £s pw | $\sigma$ |
| 6 | 23.60 | 1.11 | 14.70 | 1.15 | 21.40 | 1.20 | 21.70 | 1.20 | 29.90 | 1.23 |
| 7 | 74.00 | 1.31 | 55.40 | 1.42 | 66.30 | 1.39 | 67.30 | 1.40 | 100.70 | 1.56 |
| 8 | 108.20 | 1.43 | 80.60 | 1.57 | 96.10 | 1.52 | 97.40 | 1.53 | 148.90 | 1.78 |
| 9 | 139.00 | 1.55 | 102.40 | 1.82 | 123.50 | 1.76 | 125.20 | 1.77 | 192.20 | 2.13 |
| 10 | 197.10 | 1.82 | 147.40 | 2.25 | 176.30 | 2.14 | 178.90 | 2.15 | 281.30 | 2.74 |
| *Mean for deciles 6 to 10* | *107.60* | *1.44* | *80.60* | *1.65* | *96.70* | *1.60* | *98.10* | *1.61* | *150.50* | *1.89* |

*Notes*: Estimates of $\Delta$ are unadjusted for household composition. All monetary values are rounded to the nearest 10p and expressed in 2007 prices.

and lower $\gamma_2^{STD}$ (0.217), yielding an estimate of the extra cost of disability among disabled people of about 89 percent of their household income. Results are shown in panel (3) of Table 5.

## 7. Discussion and Conclusions

In this paper, we have applied the standard of living approach to estimate the cost of disability among older people in Great Britain and extended previous research by developing a two-latent factor structural model to estimate equivalence scales for disability. Disability is treated as a latent construct which is measured imperfectly by a vector of survey indicators and is influenced by observed socio-economic characteristics. Ten indicators of deprivation are used as observable counterparts of the latent continuous index of SoL, which varies in relation to household income and disability. Our approach allows us to construct a base-dependent equivalence scale (i.e., one which varies by income level) which takes account of the severity of disability. The restrictions on preferences imposed by the assumption of a base-independent equivalence scale for disability are not supported by our data. This implies that the extra income that disabled people on higher incomes need to be as well off as their non-disabled counterparts is lower than the equivalent sum needed by disabled people on lower incomes. Our application is the first, to our knowledge, to derive an equivalence scale for disability using a log-quadratic function on income of the kind that has been used in Engel curve studies.

The results show that the extra costs of disability are substantial, and rise with severity. Using the 2007/08 wave of the FRS we estimate that an older disabled person, defined as someone above the median level of disability for all older people, requires a net household income around 62 percent higher than that of a comparable person with a median level of disability to reach the same standard of living. This corresponds to around £99 per week on average as an allowance for the additional costs that households with a disabled member face. These additional costs where disability is in the highest decile of disability average £180 under our preferred model. The latter is comparable with disability costs for highly disabled pensioners estimated by Zaidi and Burchardt (2005), which ranged from £122 to £190 (converted to 2007 prices from £104 to £162 in 2002 prices).

Only about 27 percent of those whom we estimate to face disability-related costs, are in receipt of disability-related cash benefits. In line with previous findings (Thompson *et al.*, 1990; Berthoud *et al.*, 1993) we find evidence that, although disability benefits are received mainly by people who do indeed face disability costs, they do not meet the full costs of disability for recipients, and a high proportion of people with severe disability do not receive disability benefits at all.

We have also investigated the sensitivity of our estimates to various aspects of the econometric specification, the measurement of SoL, and the treatment of housing wealth and costs. Estimates obtained using the preferred quadratic model are remarkably close to those obtained when a simple linear-in-income form is used. The estimates are sensitive to whether the disability costs and equivalence scales are constrained to be the same for single people and couples: the reduction in living standards for a given disability level appears to be higher (but not parallel) for single people than for couples. This is in contrast to Zaidi and Burchardt (2005), who found that disability costs were higher for single people than for couples. As a consequence there is more divergence between our and their estimates when single people and couples are distinguished. Zaidi and Burchardt found that highly disabled single pensioners faced extra costs of around £189 (2007 prices) compared with our estimate for single pensioners in the highest decile of disability of £147. The equivalent comparison for couples is £122 against our higher figure of £197. Thus while there is evidence that disability benefits systems should discriminate between single people and couples, more research is needed before firm recommendations for policy can be made. Our estimates are only marginally sensitive to the inclusion of the return on housing wealth in income.

The estimated equivalence scale is very sensitive to the way answers to survey questions on deprivation are interpreted. If we were to interpret all cases of non-possession as equivalent to deprivation, we would estimate that an older disabled person requires a net household income around 89 percent higher than a comparable non-disabled person to reach the same standard of living, compared with 62 percent when the index is based only on explicit inability to afford.

Our clear—and robust—conclusion is that disability costs faced by older people in Britain are large and increase strongly with severity of disability. Comparisons of the incomes of disabled and non-disabled older people must make adequate allowance for these costs if meaningful inferences about their relative living standards are to be drawn.

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## Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

**Table A1:** Summary Statistics for Standard-of-Living and Disability
**Table A2:** Sample Means and Standard Deviations of Covariates
**Table A3:** Standard of Living and Disability Measurement Equations
**Table A4:** Estimates of the Structural Parameters of the Disability Equation
**Table A5:** Parameter Estimates from the Standard of Living Equation in the Three Variants
**Figure A1:** Estimated Form of the Income-SoL Profile
**Figure A2:** Kernel Density Estimator of $\eta$